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Site Suitability Modeling in the Sand Pine Scrub of the Ocala National Forest

Jelane M. Wallace

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Site Suitability Modeling in the Sand Pine Scrub of the Ocala National Forest

by

Jelane M. Wallace

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in Applied Anthropology
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ABSTRACT

Central Florida’s Ocala National Forest is the largest remnant of the unique-to-the-region Sand Pine Scrub ecosystem. This ecosystem exhibits a surprising wealth of biodiversity despite what may be characterized as barren, difficult, dry, pyrogenic conditions. Significant prehistoric sites exist throughout the forest, even in the Sand Pine Scrub; however, most are on the margins and few systematic surveys penetrated this ecosystem, until now. I utilized GIS and these recently collected archaeological survey data, in conjunction with other environmental, geological, or historical data in GIS format, to model prehistoric settlement and land use patterns. This model attempts to address questions of prehistoric peoples’ interactions with environments that have long been considered marginal, ‘empty,’ or even ‘too difficult’ by modern assessments to have been utilized. The model I developed explored the geospatial relationships between GIS layers for soil types, elevation, water source types, historic trails, and prehistoric midden or mound site locations as potential variables for ‘predicting’ prehistoric site locations. Ultimately the layers that I found worked best in the predictive model were several specific soil types, a distance of less than 300 m from the lake/swamp waterbody layer, and a limited, lower elevation range. The model, when tested, proved quite effective at indicating areas of site suitability. While the model is reductive to only two or three environmental factors being important in predicting the majority of the locations suitable for archaeological sites in the Sand Pine Scrub, this is not unexpected since the Big Scrub of Ocala NF is in some ways a limited ecosystem.
CHAPTER ONE: INTRODUCTION AND RESEARCH QUESTIONS

Filling in the ‘blank’ spots on the map has almost been a compulsion for many throughout history. Archaeologists are no strangers to this pursuit. Yet, frequently the focus in archaeological research is upon locations where more obvious evidence of human activities is concentrated, areas with apparent attraction for settlement or use due to common resources, or places where the material record is plainly plentiful. But what about the marginal areas? What about environments which may present more challenges, have fewer obvious, standard resources, and/or those which show less evidence of past human-environment interactions? What can we say about the behaviors of past peoples in these types of ‘empty’ landscapes (Campana 2015), the choices they may have made, or how they might have navigated and interacted with environments ‘off the beaten path?’ Is the emptiness a result of avoidance or abandonment (Gazin-Schwartz 2008)? And if these areas are “maligned as ‘marginal’ for human occupation,” for whom or to what is an area actually marginal, as Sassaman (1993) has asked? These types of areas raise questions of how we, archaeologists or not, perceive lands as empty and even more ‘pristine’ or ‘natural’ simply because our modern paths do not venture into or traipse across them. In interpreting past human-environment interactions, when the evidence is so dispersed and minimal, can we model any patterns if we examine them at the larger scale? One such marginal landscape, in which I am exploring some of these questions, is that area long known as the ‘Big Scrub’ of the Ocala National Forest (NF) in Florida.
The Ocala NF in north-central peninsular Florida encompasses nearly 162,000 hectares (400,000 acres), over half of which is the unique-to-Florida Sand Pine Scrub ecosystem representing a relict chain of islands from when the sea was once higher (U.S. Department of Agriculture, U.S. Forest Service [USDA-USFS] 2018a; World Wildlife Fund [WWF] 2018). This particular ecological setting, often called the ‘Big Scrub,’ has been described as a ‘concealed desert’ from “whose parched infertility there reared, indifferent to water… a limitless, canopied stockade…impenetrable, for a man-high growth of scrub oaks, myrtle, sparkleberry and ti-ti filled the interstices” (Rawlings 1933:2; Simmons 1822:34). This xeric, pyrogenic ecosystem exists now

Figure 1. Sand Pine Scrub ecosystem in Florida, in green, with notable preserves or forests labeled (after Myers 1990: Fig 6.3; data: Florida Natural Areas Inventory [FNAI] 2010, 2018; map by author).
as a series of strung-out sand ridges paralleling the coasts. It represents what was once a sandy island archipelago when water levels were higher and much of Florida was submerged (Figure 1). Sand Pine Scrub ecosystem in Florida, in green, with notable preserves or forests labeled (after Myers 1990: Fig 6.3; data: Florida Natural Areas Inventory [FNAI] 2010, 2018; map by author); Myers 1990:156). Despite the difficult and often dry conditions, due to a dearth of standing/flowing water resources rather than a lack of rain, this singular ecosystem displays a surprising wealth of biodiversity as well as archaeological evidence of prehistoric peoples’ activities within this environment.

Highlighting the history of conditions in the forest are historical accounts, both archaeological and ecological, made by past visitors to this unique and challenging area. One of the earliest European visitors to explore the forest region and to describe in detail what he encountered was naturalist William Bartram (1739-1823). He kept a thorough journal and later published a report about his travels through Spanish East Florida in 1774, which included a stop in August of that year at Salt Springs (Site 8MR2322) and Silver Glen Springs (Site 8MR123) in the eastern portion of the Ocala NF (Bartram 1791). Bartram looked west to the Scrub from Silver Glen Springs and was greeted by “an almost endless view of a vast barren desert, altogether impenetrable, so thickly overgrown with short scrubby Oaks, Bays, Yapon, Prinos and short laurel bushes” (Bartram 1791:163). The plants designated by Bartram as Prinos are noted in the 1943 annotations to his work as being of the genus *Ilex*, likely representing the gallberry bush (Harper 1943:218).

Nearly one hundred years after Bartram’s trek, Jeffries Wyman (1814-1874), curator of the Peabody Museum at Harvard University, also visited the region in 1867 and wrote about shell mounds along the St. Johns River, which forms the eastern edge of the forest (Wyman 1875).
Many of these ‘shell heap’ sites he documented were extensive, dense, and deep, providing stratigraphic and artifactual evidence for long-term and large-scale utilization of the area on the margins of the Big Scrub for prehistoric settlement and subsistence (Randall 2015). Yet despite this, there never seems to have been a perception of many people living in or utilizing the Big Scrub. This unique environment, and how seemingly little impacted it had been by people, was strikingly described by author, and resident of rural Florida, Marjorie Kinnan Rawlings (1896-1956). She wrote in *South Moon Under*, her 1933 novel about a family living in the Big Scrub, that:

> men had had reached into the scrub and along its boundaries, had snatched what they could get and had gone away, uneasy in that vast indifferent peace; for a man was nothing, crawling ant-like among the myrtle bushes under the pines. Now they were gone, it was as though they had never been. The silence of the scrub was primordial. The wood-thrush crying across it might have been the first bird in the world—or the last (Rawlings 1933:119).

Another illuminating vignette about the forest comes from an early resident of Florida in its American territorial period, Dr. William Hayne Simmons (1784-1870). In the winter of 1822, Simmons traveled the area as part of a commission for choosing a governmental seat for the United States’ newly acquired Florida Territory, and later published his account of the Seminoles living in East Florida (Simmons 1822). He offered up his observations of their hunting practices utilizing the then extant trails within the forest. According to Simmons, the scrub:

> forms a complete live fence, which, probably, would never have been penetrated through but by the Indians, who made the present trail for the purposes of hunting the bear; that animal frequenting these spots at certain seasons of the year, in order to feed on the acorns that abound in them. It is his habit to stop when he comes to a path, and reconnoitre [sic] it before he crosses; and the Indians, aware of this, formed these trails, which afford them an opportunity of killing him with great certainty. Some of the hunters station themselves along the path, while others go into the thickets, and drive the bear towards the ambuscaded spot,
where stopping, he is easily shot down. —The wild turkies [sic], also, are said to be numerous here (Simmons 1822:34).

Another of the visitors to the region of the Ocala NF, and one who impacted the archaeological record of the region, was avocational archaeologist Clarence Bloomfield Moore (1852-1936). He sailed up the Ocklawaha in 1895 to map and explore the general locations of sand mounds along the river course. This route would have taken him along the margins of the Big Scrub and, when he encountered mounds, with an “abundant force of men,” he proceeded to “completely demolish” them while “making an account of those offering any interest either structurally or as to human remains or relics of aboriginal art” (Moore 1999[1895]:139). The general vicinity is all we know for some of these mounds he visited, while others have since been relocated and better recorded in modern times. One such mound is Palmetto Landing 7 (8MR25), for which only the description from Moore remains while its location is only roughly placed. Given the information from Moore and these other varied visitors’ accounts, what stands out is that, though the forest presented a challenge to traverse, it was also immediately adjacent to past peoples’ settlements and for the sake of resources or other reasons it was being utilized.

Some of the evidence of these past utilizations of the forest have been logged and explored in the hundreds of archaeological sites recorded in the Ocala NF. Much of this effort at investigation is concentrated on the margins of the forest, outside the bounds of the scrub. Very few archaeological investigations, and almost none of them systematic, had been done in the Sand Pine Scrub of the Ocala NF due to the difficulty of the terrain, time required, and prohibitive cost. Previous cultural resources work in the forest had been sporadic, until the 1970s, and none had included stratified testing with random sampling until Ocala NF Archaeologist Raymond Willis’
work began in 1977 (Dorian 1984:19; Willis and Wells 1977). Little, therefore, is known about
the interactions between prehistoric peoples and this biodiverse forest.

But recently, beginning in 2015, over 4,000 hectares (10,000 acres) have been the subject
of systematic archaeological survey, resulting in the documentation of sites within the Sand Pine
Scrub. Having participated in this large-scale, systematic survey in the Ocala NF, I have
experienced some of the challenges associated with traversing and conducting archaeological
surveys in portions of this Sand Pine Scrub ecosystem (Mikell 2017; Willis 2016a, 2016b). In
collaborating with the staff of the Ocala NF, I stumbled across a research question quite by accident
and to my surprise. Why, given how dry and difficult the interior of the Big Scrub can be, would
there be archaeological sites located within its bounds? What potential factors drew Florida’s past
inhabitants into and across this region? What sorts of resources or reasons would there be for
entering, hunting, camping, foraging or even living in the Sand Pine Scrub ecosystem of the Ocala
NF? Could a geographic comparison of some known variables, environments and site placement
point to any of these reasons?

Therefore, since staff at the Ocala NF expressed interest in a means of ‘predicting’ site
locations on their lands, the objective of this thesis is to draw from settlement pattern and landscape
archaeology perspectives and Geographic Information System (GIS) technology to develop a site
suitability model for prehistoric sites in the Sand Pine Scrub of the Ocala NF. My approach aims
to be useful for both the Ocala NF in their conservation efforts of this public land and its cultural
resources as well as hopefully furthering the understanding of prehistoric land use and settlement
patterns in this unique region of Florida. The research questions I am asking are: what patterns, if
any, may be observed from geospatial comparisons and explorations of the archaeological site,
environmental, and other digital data sources for the Sand Pine Scrub ecosystem of the Ocala NF?
Is there any evidence for areas that were more suitable for prehistoric sites than others in the Sand Pine Scrub ecosystem? What environmental factors or conditions may have played a role in where sites are located? Can a model for the locations of these suitable areas for site locations be generated in GIS with any degree of accuracy or confidence? Is there even enough geospatial data or archaeological site data to confidently create such a model for the Sand Pine Scrub of the Ocala NF?
CHAPTER TWO: BACKGROUND

Environmental Setting

The Ocala NF is one of only three national forests located within the state of Florida (Figure 2. Aerial image showing the locations of the National Forests of Florida (basemap: ESRI 2018; data: USDA-USFS 2017; map by author).). It includes portions of three counties (Lake, Marion,
and Putnam) and, as a federally designated region for natural conservation, is an expansive area in the peninsula of Florida which has not been subjected to large scale development at the same rate as has much of the rest of the state. The Ocala NF itself has two watersheds that form some of its boundaries. On the west and north sides of the forest, the Ocklawaha River meanders. On the east side of the forest, the St. Johns River and Lake George form a natural boundary. The St. Johns is unique for being one of the few rivers in the region that flows south to north and since the earliest European explorations of the region in the sixteenth century has served as a vital transportation route. The Ocklawaha is not as large as the St. Johns and has an intermittent tributary called the Dead River.

Figure 3. Ocala National Forest, shaded green, Florida (basemap: ESRI 2018; map by author).
The ‘Big Scrub’ is characterized by deep, low fertility, drought-prone sandy soils which support any mix along the spectrum of shorter, thickly-growing shrubs to taller, well-spaced pine trees. This ecological area is also well adapted for large-scale disturbances, such as wildfires (USDA-USFS 2018b). Carolyn Sekerak, Deputy District Ranger, formerly the Supervisory Wildlife Biologist for Ocala NF, noted that in regards to the pine species of the Big Scrub, their being “pyrogenic is more than fire-dependent, it is defined as strategies that are fire generators. There are adaptations in the plant physiology that contribute to the spread of fire, that evolutionarily benefit the plant’s ability to compete over other species” (Carolyn Sekerak, personal communication, 2021).

In fact, Sand Pines (*Pinus clausa*) are often reliant upon periodic wildfires to clear undergrowth, open seed cones, and ensure their propagation since they have “the capacity to regenerate profusely following fire” (Myers 1990:162). These fires will typically naturally occur at a frequency of every five to 40 years (FNAI 2010; WWF 2018); however, based on the life-cycle of sand pines, fires might have stretched to 50- or even 80-year intervals (FNAI 2010:51). Because of the fire-generating techniques of the sand pines, where they will ‘varnish’ themselves with highly-flammable sap to the point that it drips onto surrounding vegetation, a lightning strike can set off a spectacular wildfire in the sand pine scrub. In 1935, one such fire was able to burn 35,000 acres (140 km²) in just four hours, with three-quarters of this total burning in the last hour (FNAI 2010:52; USDA-USFS 2018b). Wildfires in this ecosystem inspired the Ocala NF Ranger John Cooper (1938-1943) to indicate that “the best fire control in the Big Scrub is and always has been to never let a forest fire get into the sand pine” (USDA-USFS 2018b).

Myers points out that the scrub ‘islands’ we see today are “a remnant of an old and formerly extensive ecosystem” from the generally cooler and drier late Pleistocene (44,000-10,000 BP).
It is presumed that the generally warmer and wetter climate that followed this caused the contraction of the scrub to only the ‘droughtier soils’ by about 7,000-5,000 BP (Myers 1990:155). This ecological area now only exists in small, segmented pockets, the largest of which is the Ocala NF.

Dryness remains the defining characteristic of the Scrub. Current precipitation records show an annual average of 113 cm (44.5 inches) from 1961-1990 and 118 cm (46.5 inches) from 1981-2010 (USDA-NRCS 2017). The climate throughout the forest is uniformly warm in the summers but winters grade milder further south in the forest (USDA-NRCS 1975:57). Chemical reactions in the soils of the forest, of which there are over 90 unique soil types mapped, are accelerated by these climate conditions (USDA-NRCS 1975, 2017). This acceleration leads to the swift decomposition of organic materials. Strong acid reactions, downward dissemination of insoluble fine particles, and leaching of plant nutrients characterize most of the sandy soils of the Ocala NF, decreasing the organic content and available water, and thus the overall fertility of these sediments (Myers 1990:157; USDA-NRCS 1975:57).

Yet there is still a wealth of species, some endemic, to be found within this ecological area. The flora present today within scrub ecosystems includes sand pine and its peninsular Ocala variant (Pinus clausa var. clausa), both myrtle and scrub oak (Quercus myrtifolia, Q. inopina), saw palmetto (Serenoa repens), sand live oak (Q. geminata), Chapman's oak (Q. chapmanii), rusty lyonia (Lyonia ferruginea), Florida rosemary (Ceratiola ericoides), four-petal pawpaw (Asimina tetramer), Curtis milkweed (Asclepias curtissii), and ground lichens (Cladonia leporina, C. prostrata, Cladina subtenuis, and C. evansii). Among the endemic flora species are scrub holly (Ilex opaca var. arenicola), silk bay (Persea humilis), garberia (Garberia heterophylla), palafoxia (Palafoxia feayi), wild olive (Osmanthus megacarpa), scrub morning glory (bonamia
grandiflora), and longspur red mint (*Dicerandra cornutissima*) (Florida Forest Stewardship Program [FFS] 2018; FNAI 2010; Myers 1990:162-3; USDA-USFS 2018b).

Fauna that are today found in the scrub include black bear (*Ursus americanus floridanus*), white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale putorius*), raccoon (*Procyon lotor*), flying squirrel (*Glaucomys volans*), gray squirrel (*Sciurus carolinensis*), hairy woodpeckers (*Picoides pubescens, P. villosus*), great crested flycatcher (*Myiarchus crinitus*), eastern screech-owl (*Otus asio*), Cooper’s hawk (*Accipiter cooperii*), gopher tortoise (*Gopherus polyphemus*), and black racer (*Caluber constrictor*). Endemic species of the scrub are the Florida mouse (*Podomys floridanus*), the Florida scrub jay (*Aphelocoma coerulescens coerulescens*), the Florida scrub lizard (*Sceloporus woodi*), the blue-tailed mole skink (*Eumeces egregius lividus*), the short-tailed snake (*Stilosome extenuatum*), and the now extinct Goff’s pocket gopher (*Geomys pinetis goffi*) (FNAI 2010:49-53; Myers 1990:163-5). Wolves, either black (*Canis lupus floridanus*) or red (*Canis lupus rufus*) were also once found across the southeast, including the Big Scrub, before they were hunted to extinction in the wild in the early 1900s (Chambers et al. 2012:9; Florida Fish and Wildlife Conservation Commission [FWC] 2021; Rawlings 1933:6). Prior to modern development, the Florida panther (*Puma concolor coryi*) would also have been an important part of the fauna found in the Ocala NF area and, despite breeding populations being centered in south Florida, young males still range through the Ocala NF today (FWC 2019).

There seems to be a disparity between the current ecological and environmental evaluations of the sand pine scrub ecosystem when it is compared with observations made of it by early European or American visitors to the region, and even a disconnect with assessments made of it by later archaeologists. On the one hand, from a biological perspective, the unique nature of this
ecosystem is emphasized as well as the species endemic to it; however, on the other hand, it is described in terms that make it seem less than hospitable (sterile, dry, barren, desert). An observation or an opinion that echoes through the archaeological overviews and valuations of the ‘Big Scrub’ is that people in the past were not ‘doing’ much in this region. In a cultural resources summary for the Ocala NF, Forest Archaeologist Alan Dorian, who spent decades focused exclusively on the Ocala NF, determined that “no significant prehistoric or historic sites have been identified within this zone, indicating that the probability of these properties is extremely low” (Dorian 1984:4). The conclusion he arrived upon was that the Sand Pine Scrub ecosystem served “primarily as a zone of transportation with a secondary use for resource exploitation (perhaps coontie/Zamia tubers)” (Dorian 1984:4). Footpath or foraging are completely understandable and likely uses of this ecological zone, but is there more to this unique forest? The following section explores some of the previous archaeological work that has been done in the Ocala NF and some of the sites upon which these conclusions are based.

**Previous Archaeological Investigations**

Of the nearly 1,000 previously recorded archaeological sites throughout the Ocala NF as a whole, most are clustered around the water sources that flow around or form the boundaries for the forest (Dorian 1984; FDHR 2017). Less than 250 (25 percent) of these sites are found within the Sand Pine Scrub of the Ocala NF, despite the fact that this ecosystem comprises the majority (53 percent) of the area within this forest. The temporal periods represented in this ecosystem span the breadth of Florida’s past cultural chronology, though some phases are better represented (Table 1). As of 1984, Dorian (1984:4) had noted that about 8,100 hectares (20,000 acres) of the Sand Pine Scrub had been ‘inventoried’ for sites, but no ‘significant’ prehistoric sites were recorded.
Among the previous archaeological survey work noted in the FMSF (FDHR 2018) as having been conducted in the Sand Pine Scrub, 18 were utility, cellular, pipeline, or transportation corridors (Almy et al. 1991; Ambrosino 2000; Arbuthnot and Azevedo 2015; Batategas 2000; Chambless 2009; Daniel 1984; Dickinson et al. 1992; Dickinson and Wayne 1994; Janus Research 2004; Nodine 2015; Nodine and Suarez 2014; Pochurek 2000; Stokes 1999, 2000; Voellinger and Voellinger 1980; Wayne 1992; Wells 2001; Willis 2006a) while seven represented more general archaeological surveys that were not limited to narrow corridors (Almy et al. 2012; Boyer 2006; Dunbar and Newman 2004; Johnson 1999; Randall et al. 2011; Willis 2006b, 2012).

**Table 1. Cultural Periods Represented by Sites within the Ocala NF Sand Pine Scrub (FDHR 2018)**

<table>
<thead>
<tr>
<th>Cultural Period (FMSF)</th>
<th>Site Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic (general)</td>
<td>13</td>
<td>4.7%</td>
</tr>
<tr>
<td>Seminole 1716-present</td>
<td>2</td>
<td>0.7%</td>
</tr>
<tr>
<td>Alachua A.D. 1250-1600</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>St. Johns 700 B.C.-A.D. 1500</td>
<td>78</td>
<td>28.5%</td>
</tr>
<tr>
<td>Belle Glade 700 B.C.-A.D. 1700</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>Deptford 700 B.C.-300 B.C.</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>Orange 2500 B.C.-1000 B.C.</td>
<td>6</td>
<td>2.2%</td>
</tr>
<tr>
<td>Mt. Taylor 4000 B.C.-2000 B.C.</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>Archaic 8500 B.C.-1000 B.C.</td>
<td>47</td>
<td>17.2%</td>
</tr>
<tr>
<td>Paleoindian 10,000 B.C.-8500 B.C.</td>
<td>2</td>
<td>0.7%</td>
</tr>
<tr>
<td>Prehistoric (general)*</td>
<td>124</td>
<td>45.3%</td>
</tr>
</tbody>
</table>

*Includes isolated find point data (USFS 2017)*

The 2018 data from the FMSF note nearly 200 archaeological sites in the Sand Pine Scrub. There is a wide range to the temporal components noted by the FMSF for the sites recorded within the Sand Pine Scrub as well (Table 1) (FDHR 2018). For research purposes, I excluded sites in the area of interest which solely included historic components and lacked any prehistoric components. The GIS data from the USFS dated 2017 shows virtually the same number of sites, the vast
majority of which overlap with the FSMF data, but also includes several dozen additional point features (USFS 2017). The discrepancy can be explained by the USFS recording and keeping digital GIS records for isolated finds (or archaeological occurrences as they are called by the FMSF) while the FMSF usually does not note such small (less than three artifacts in a 30 m/98 ft radius) artifact assemblages (FDHR 2011). Due to the limited nature of the single artifact finds represented by the point data, these often lack any temporal codification beyond a general category of ‘prehistoric’ or ‘historic’. Despite noting these limitations, I still chose to utilize the general prehistoric isolated find point data. Without the inclusion of these smaller interactions of past peoples with the forest, our potential understanding of how, why, and in what ways prehistoric groups utilized this ecosystem would be less inclusive and more limited. By only looking at larger sites, and ignoring small artifact occurrences, our lens can narrow unnecessarily. In total, there were 226 sites or isolated finds included in this research.

Of the significant archaeological sites recorded on the FMSF as being in or immediately adjacent (less than 100 m/328 ft. distance) to the Sand Pine Scrub, eight represent shell middens (8LA27, 8MR7, 8MR75, 8MR76, 8MR123, 8MR255, 8MR1970, 8PU41), nine represent burial mounds (Sites 8LA233, 8LA4379, 8MR25, 8MR123, 8MR1102, 8MR3254, PU42, 8PU677, and 8PU1217), while two represent sand mounds of undetermined function (8MR146 and 8MR768) (FDHR 2018). Researchers at the University of Florida have conducted intensive investigation at one of the mound sites, Silver Glen Run (8MR123) (Gilmore 2016; O’Donoughue 2017; Randall et al. 2011; Sassaman et al. 2011).
Recent Archaeological Investigations

Retired former Archaeologist for Ocala NF, Raymond Willis, Ph.D., indicated that first Alan Doren and later he himself, working as archaeologists in the forest over the course of four decades, had primarily utilized surface survey of hundreds to potentially thousands of miles of exposed plow lines of timber-sale stand perimeters. Subjectively placed subsurface testing was occasionally conducted in proximity to past water sources in the Scrub, but since the scope of the assessments prior to 2014 were more limited, so too were the testing strategies. Willis noted that they “observed an apparent pattern of extremely low site density in this extremely xeric environment” and that it was not until 2015 that “large-scale systematic subsurface testing finally became feasible” with the implementation of a new landscape-wide Environmental Assessment land management approach to the Ocala NF (Raymond Willis, personal communication, 2021). These larger land surveys were designed by Willis to include much more extensive subsurface excavations with the goal of testing “the working hypothesis of extremely low site density in the sand pine scrub ecosystem...to use to refine future archeological survey” in that particular environmental setting in the Ocala NF (Raymond Willis, personal communication, 2021).

In fact, prior to 2015, the Florida Master Site File (FMSF) notes that only 25 surveys had included the Ocala NF; few of them were systematic or had been conducted within the Sand Pine Scrub Ecosystem (FDHR 2018). In 2015 and 2016, more extensive areas of the Ocala NF in general and of the Sand Pine Scrub Ecosystem were conducted (Willis 2016a, 2016b). As of 2017, over 4,000 hectares (10,000 acres) of the Ocala NF had been systematically surveyed for traces of prehistoric sites, which “represents the most intensive regime of area-wide screened subsurface testing ever conducted primarily within the sand pine scrub ecosystem of the Ocala National Forest” (Willis 2016:15). Sites were located and recorded accurately within the Sand Pine Scrub
ecosystem. These GIS data are maintained by the Ocala NF and include sub-meter accurate plots of prehistoric artifacts and sites. The records of the FMSF note only a handful of surveys, which did not often include subsurface testing, had penetrated the Scrub prior to 2015. Examples of some of these surveys included such types of investigation as a narrow pipeline corridor survey (Voellinger and Voellinger 1980) and a surface observation reconnaissance survey, for obvious reasons, of the U.S. Naval bombing range (Johnson 1999).
CHAPTER THREE: THEORY AND METHODS

Theory

As a theoretical perspective, I am drawing from evolutionary theory in anthropology, specifically human behavior ecology (HBE), which is applicable in providing insights into past cultures where all that remains are the imperfectly preserved archaeological record (Bird and O’Connell 2006; Codding and Bird 2015). In the absence of historical documents, any ethnographic interpretations from modern sources are conjectures about past practices. These conjectures aim to be logical, predictive, and oftentimes take the form of simple models. For the study of prehistoric sites as reflections of past human-environment interactions in the region of the Ocala NF, questions about hunter-gatherer (fisher, forager) subsistence strategies posed in light of these theoretical perspectives can focus on assumed, inferred, logical choices. Such choices are ideally suited for modeling in GIS with statistical or spatial parameters for site suitability or environmental factors in resource utilization. As part of its theoretical approach, HBE has developed and includes some utilitarian modeling concepts (Codding and Bird 2015), such as Optimal Foraging Theory (OFT), Central Place Foraging (CPF), as well as models of field processing, mobility, and settlement.

Another HBE modeling concept, drawn from behavioral ecology via ornithology, and related to niche construction theory (NCT), is that of the Ideal Distribution Model (IDM) (Codding and Bird 2015; Hale and Sanger 2020; Weitzel and Codding 2020). Weitzel and Codding (2020:1) note that “recently, these half-century-old models have inspired novel and exciting applications,
particularly in the field of archaeology” and may prove applicable for working toward a “unifying theoretical framework.” This particular theoretical approach seeks to develop predictions about how populations, both non-human and human, distribute themselves across a landscape (Weitzel and Codding 2020:1). The key underlying supposition is that organisms, and by extension, people, will seek a suitable habitat. What makes it suitable, or ideal, can be affected by a range of factors as diverse as distance to necessary or desired resources, or even factors which influence ‘reproductive success.’ An equilibrium would be sought by those in the habitat as new individuals are added to and effect suitability. There are three variants to the IDM, depending on how adding new individuals affects suitability (Weitzel and Codding 2020). For Ideal Free Distribution (IFD), proximity to others is not beneficial and movement is not restricted. For free distribution conditions with Allee effects, an initial positive effect comes from the addition of new individuals, up to a threshold, which represents an optimal group size. With ideal despotic distribution (IDD) the territoriality of an individual either raises or lowers the suitability of a particular location, affecting distribution within the habitat (Weitzel and Codding 2020:2).

Several expectations Weitzel and Codding (2020:2) point that can be derived from ideal distribution models are that “(1) individuals should always settle in the more suitable habitat first and (2) that as long as suitability declines at similar rates as a function of density across the two habitats, the more suitable habitats will always have a higher population density.” When people first enter a region, IDM supposes that they will focus primarily on areas “with the highest net return rates for resource extraction; non-food variables such as distance to raw materials for technological activities or other population centers often play critical roles in the IFD” (Hale and Sanger 2020:2). These qualitative predictions could help to shed light on past peoples’ interactions
with their environment. It could also be used to explore settlement patterns, the relative chronology of site distributions across a landscape, and even potentially explore the prioritization of resources.

Critiques of theoretical approaches deriving from an HBE perspective can point to a lack of human agency or meaning as well as being overly reductive to the human lived experience as being failings to this approach; however, proponents of this theoretical perspective point to the strength of simplifying the questions asked in order to focus on what little data is actually available regarding past hunter-gatherer peoples. Models created using a theoretical perspective that draws from HBE would ask questions about what available resources were utilized by past peoples, how did they move through or negotiate their lives within a particular environment, what choices were made in utilizing that environment, and whether patterns or changes can be found over time in the human-environment interactions. Further, the locations chosen for settlement and the pattern of these settlements would be assumed to reflect the need to optimize resource accessibility. Where people spent time, where they lived would be almost dictated by the various resources or environmental factors necessary for their life, according to this theoretical perspective.

Given that there is a limited collection of sites and mainly environmental geospatial data sources for the Sand Pine Scrub ecosystem in the Ocala NF, this HBE theoretical perspective seemed ideal to me for developing a site suitability model. The actual ecosystem is often considered marginal, thought of by previous archaeologists studying the forest as relatively empty of evidence for past use by prehistoric peoples, and frequently called challenging when encountered by historic as well as modern individuals. Being reductive, as the HBE perspective can be called, might actually be a strength and work in favor of GIS modeling for predictive site modeling in this type of environment. In employing IFD to understand human settlement patterns, Jazwa et al. observed that working with “a limited array of settlement options…[and] a relatively
limited and thus manageable number of natural resources, facilitate[d] accurate assessment of suitability” (Jazwa et al. 2016:1243).

In terms of the perspectives regarding the use of GIS in archaeological modeling, its expediency is difficult to deny (Kvamme 2006; Lock and Pouncett 2017). This does not however mean that it can be applied everywhere or without careful thought to how, as a tool, it might or might not be successfully be applied to research questions (Burg 2017:115). Kvamme specifically enumerates the efficacy of using quantitative, spatial data analysis, including GIS based data analysis, because of the methodological rigor as well as the potential this type of analysis has to offer explanation (Kvamme 1980:386; 2006). Yet, the use of GIS in model building faces some of the same limitations as other means of spatial analysis. One of the potential shortcomings of this method is that simply inputting archaeological spatial data into a computer for it to spit out analysis on the other side can create the circumstances by which significance gets lost along the way (Jones 2017:55). Several researchers have argued that a loss of context and even meaningful significance could occur with quantitate, often computer-program driven analysis of spatial archaeological data (Burg 2017; Jones 2017; Kintigh and Ammerman 1982). Complex issues and relationships that are potentially present can be flattened or stripped away in the process. Past human behavior and decision making would be a wonderful and informative pattern to construe or reconstruct from spatial archaeological data. If not applying the appropriate tools to properly address a research question, the researcher may lose sight of what they set out to explore or find that no productive insight is offered by the analysis performed (Jones 2017:55). Bell and Lock (2000) point out that both cultural and archaeological knowledge in conjunction with a consistently grounded theoretical approach are essential to the process of creating a model with meaning. In analyzing spatial archaeological data, there also needs to be an understanding of spatial statistics and an
evaluation against the characteristics of the landscape, such that random distribution is not mistaken for patterning and spatial correlation (Jones 2010; Kvamme 1990). Jones (2017:60) even states that “[o]ne can easily make the argument that the spatial relationship between archaeological remains (e.g., sites) is the most critical contextual data we collect. As such we need our spatial methods to test for patterns, not simply identify them by qualitative observation.”

The use of GIS modeling in archaeology is not new, nor is modeling with GIS technology a one-size-fits-all approach in archaeology (Kvamme 1995, 2006; Wheatley and Gillings 2002). Anywhere from minimal mapping to complex database and geospatial relationship explorations can be a part of this process. Often in archaeological predictive modeling, the variables chosen to focus on are “derived from \textit{a priori} theoretical ideas,” which matches up with the HBE perspective of certain ecological or environmental conditions and factors shaping the activities of past people and thus the locations of sites (Kvamme 2006:21). Kvamme also points out that a “model fine-tuned to the more limited variation of a small region should theoretically better ‘fit’ that region’s cultural and environmental variability” (Kvamme 2006:21). I argue that the Sand Pine Scrub of the Ocala NF fits this description, as a well-defined area with relatively well known and limited factors to ‘plug’ into a theoretical model.

Another important aspect of using GIS in creating a model for predicting site suitability locations would be the testing of that model. How effective, for example, is it in identifying places where sites are likely to be found? The process of “bootstrapping,” or holding back part of the data which were not used to create the model, and then testing it against that reserved data, is a robust way to evaluate these GIS predictive site models (Kvamme 2006; Warren and Asch 2000). As part of the testing of the model, the percent correct statistic would represent the number of already known sites, those held back in the reserved group not used to develop the model, whose locations
are correctly predicted by the model. This would simply be “the percentage of known sites that a model gets right…can be referred to as ‘model accuracy’ for the archaeological class” (Kvamme 2006:24). Thus, if in developing the model, the data are divided into separate groups such that a reserved set of sites can be later tested against the built model, that percent of sites correctly predicted by the model would represent the accuracy of the model.

Methods

The data I have gathered or accessed include georeferenced digital files pertaining to modern environmental conditions, such as vegetation, water, or soil resources, as well as geospatial files for archaeological surveys and site locations. Much of these data have been very recently (within the past 5 years) collected or updated. The majority of the data already exist digitally and can be readily obtained from various online databases, government data clearinghouses, download websites, or online records (). An exception to this would be the data maintained by the FMSF and USFS, for which use of their data required a signed statement or agreement on the part of the authorized user not to disseminate sensitive information, such as archaeological site locations or burials. The GIS software I used is ArcMap 10.7.1 from ESRI.

The Florida Division of Historical Resources (FDHR), Master Site File (FMSF) maintains GIS data files for cultural resources across the state as a whole (FDHR 2018). These files contain information about such things as archaeological sites or even historic cemeteries, for instance. The layers I selected were for archaeological sites and for previous cultural resource surveys. General cultural periods or chronological ranges as well as site types are included in these layers, which can be used to sort, categorize, or filter sites.
The U.S. Forest Service (USFS), as well as the Natural Resources Conservation Service (NRCS), both of which are part of the U.S. Department of Agriculture (USDA), maintain GIS databases with information pertinent to the Ocala NF and its natural and cultural resources as well as archaeological work completed in the forest (USDA-USFS 2017; USDA-NRCS 2017). From the Forest Service came layer files for sites as well as isolated finds, and information about previous surveys in the forest. These layers include very general categorization of historic versus prehistoric and generally have less description than the records of the FMSF. Mapped areas of particular vegetation, modern roads, and even timber stand and compartment boundaries are also among the types of files provided by the Forest Service. Most of the environmental data came from the NRCS. Soil types are mapped in GIS layers maintained by the NRCS for individual counties or regional areas and in this case the Ocala NF is its own subset of the soil data. The elevation data was in the form of a digital elevation model (DEM) at a resolution of three-meter intervals. Hydrography layer files also came from the NRCS, which has various types of water bodies, features, or even linear flows mapped and coded. These files proved very detailed and the code types were useful for sorting out modern water features or focusing on particular types of waterways, like rivers or springs, for instance.

LiDAR elevation data, which had been variously ordered by the Southwest Florida Water Management District (SWFWMD), Lake County Board of County Commissioners (LCBCC), Volusia County Public Works Department (VCPWD) and St. Johns River Water Management District (SJRWMD) was available from the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management through their data access viewer (NOAA 2018). The LiDAR data was at a wide range of resolutions, was not as complete and ultimately, for model building, I found the DEM sufficient for my uses.
Additionally, the Bureau of Land Management, General Land Office (BLM-GLO) has digitized the original land survey maps of Florida from the early to mid-1800s, which include the area of the Ocala NF, and provides them for download in several raster formats (BLM-GLO 2018). There is no geospatial data included with these maps. However, the maps depict environmental, topographical, and hydrological features that were originally measured, mapped, and hand drawn by the early American land surveyors (BLM-GLO 2018). I used the topographical features in conjunction with the Township and Range lines to georeference these plat maps as accurately as possible (given the gaps and occasional inconsistencies in the maps). From these maps I digitized vector layer for the trails depicted on the maps as existing in the historic period when the surveys were completed (1835-1852). I was also able to note and digitize some of the past environmental conditions portrayed on the plat maps, such as scrub vegetation, wetlands, rivers, and creeks. Ultimately the maps were so inconsistent in noting vegetation that the layer I created to show ‘scrub’ was less useful than the one presently mapped by the USDA-USFS, but it is interesting that the scrub area might be larger now than it was in the mid-1800s.
<table>
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<th>Source</th>
<th>Format</th>
<th>Date</th>
</tr>
</thead>
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<tr>
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<td>Clay and Putnam counties LiDAR</td>
<td>NOAA</td>
<td>Raster</td>
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CHAPTER FOUR: MODEL BUILDING

In my attempt at developing a predictive model, I compared multiple environmental and cultural variables using GIS software. For this exploration, the dependent variable, what I am trying to investigate, model, and perhaps predict, is locations which might be more suitable for the occurrence of prehistoric cultural sites. The distribution of all these sites in relation to the Sand Pine Scrub ecosystem is depicted in Figure 4. The independent variables, or potential explanatory factors which are explored to see what effect, if any, they might have on the dependent variable, were the collected environmental or other cultural data noted above in Table 2. Since the Sand Pine Scrub in Ocala NF is not completely contiguous, for the purposes of mapping I created a 1.5 mile (2.4 km) wide buffer around the shapefile for this ecosystem. This is designated as the area of interest (AOI) on maps and was used for clipping or cropping some of the datasets or for extents on base maps or other imagery.

In order to test the efficacy of the comparisons and modeling, the site data were divided into two separate files. In total, there are 226 sites; three quarters of these (170) were used in the development and creation of the model. These were designated as the Model Building Group or the main group. One quarter (56) of the sites were held back, designated as the Model Testing Group or the control group, for the purpose of checking how well the model could do at ‘finding’ these sites. Two approaches were compared for ways to divide the archaeological site shapefile into two separate groups, both of which involved using a web-based random number generator application and uniquely assigned field identification (FID) numbers in the GIS shapefile (Google 2021).
Figure 4. Distribution of archaeological sites in relation to the Sand Pine Scrub ecosystem in the Ocala NF; note the sites are not to scale (basemap: ESRI 2018; FDHR 2018; USDA-USFS 2017; map by author).
The first approach divided the site data based on the geographical units created by the USFS. There are 203 Compartments, all of varying sizes, demarcating the Ocala NF. The random number generator was used to exclude one quarter of the Compartments from the Model Building archaeological site data set. The sites located in these excluded Compartments were used to populate the Model Testing data set. This, however, did not produce the correctly proportioned (three quarters versus one quarter) breakdown for the groups and overall lead to a skewed dataset. An outcome like this seems logical if sites are clustered in particular areas and thus some Compartments encompass disproportionate amounts of evidence for prehistoric utilization in the form of sites. The other approach involved directly selecting the sites using the random number generator to pick the FID of 56 sites to exclude from the Model Building Group. Once excluded, they were separated into their own shapefile, the Model Testing Group. Ultimately this later approach worked best for creating the two groups when using the random number generator.

Once the Model Building Group (with 170 sites) and the Model Testing Group (with 56 sites, as a control) were set, then queries, maps, or other functions could be constructed in GIS for comparing the variables. Ultimately this boiled down to an investigation of the relationship between prehistoric sites and their surrounding landscape within the unique and liminal Sand Pine Scrub ecosystem. What follows below is my exploration, type by type, of specific environmental and cultural factors in this area and any observable relationships they might have to where sites are distributed across the landscape of Ocala NF’s Big Scrub. Following the exploration and construction of the model using the Model Building Group, the model was tested using the Model Testing Group.
Elevation

The National Elevation Dataset (NED) in the area of the Ocala NF represents 3-meter interval intersecting raster tiles depicting the elevations measured across the forest, generally derived from LiDAR data (USDA-NRCS 2017). The range in height for this topographic region is from sea level, or 0 meters (0 feet), to nearly 60 meters (197 feet) above mean sea level (AMSL). As noted above, the Sand Pine Scrub ecosystem represents a relict chain of sandy islands, now high and quite often dry. This topographic setting is strikingly visible on a map displaying this elevation data (Figure 5).

As elevations across even a very small site can fluctuate, a centroid, or central point, was calculated in GIS for each site. The elevation measurement at this central point was used as representative of the site as a whole. The range of elevations for the Model Building group of sites in the Sand Pine Scrub spanned from just above sea level, so between 0 to over 41 meters AMSL. This distribution was not equal or even, with the mean elevation being only 15 meters AMSL. From the calculated field statistics in GIS (Figure 6), a histogram of the frequency distribution for elevations in sites of Model Building Group makes it apparent that the bulk of the sites are situated between about 2 and 25 meters AMSL. This is potentially significant, in that the elevation at these sites tends to skew lower rather than higher. One possible theorized explanation for this may reflect a better chance for the pooling or collection of water, which perhaps would provide for a preferred type of vegetation or other favored and sought resource or environmental condition.
Figure 5. National Elevation Data, 3-meter interval, within the Ocala NF (FDHR 2018; USDA-NRCS 2017; USDA-USFS 2017); map by author.
Figure 6. Histogram showing the frequency distribution of elevations for sites in the Model Building data set (USDA-NRCS 2017).

The elevation data for the forest is likely among the more accurate and evenly distributed environmental data sets as it derives from LiDAR data. This makes it even more thought provoking and possibly useful in model building since there appears to be a consistently acceptable elevation range for site location potential. For this reason, in formulating a site suitability predictive model in the Ocala NF, elevation is one of the data factors I would expect elevation to be one of the more useful variables.

Soils

There are 64 specific soil types mapped within the Ocala NF, 56 of which can be found in the Sand Pine Scrub ecosystem. Each soil type is differentiated by a Map Unit Symbol (MUSYM), which is frequently a short integer or letter abbreviation. In the Sand Pine Scrub, these soils tend to be well drained to even excessively drained of any water, prone to drought conditions, sandy, but capable of supporting a wide variety of vegetation (Myer 1990; USDA-NRCS 2017). As
predictive factors for site potential, it is evident that sites are again found unequally distributed across the various soil types. Just over half (n=33, or 51 percent) of these soil types were found in relation to the archaeological sites of the Model Testing Group (Table 3; Figure 7).

Table 3. Soil Types for the Model Building Group (USDA-NRCS 2017)

<table>
<thead>
<tr>
<th>Soil Name (MUSYM)</th>
<th>Area (acres)</th>
<th>Percent of Area</th>
<th>Site Count</th>
<th>Percent of Sites</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astatula &amp; Candler sands, 0 to 5 percent slopes (2)</td>
<td>100,858</td>
<td>49.0%</td>
<td>9</td>
<td>4.3%</td>
<td>excessively</td>
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<td>Astatula &amp; Candler sands, 5 to 12 percent slopes (3)</td>
<td>14,043</td>
<td>6.8%</td>
<td>19</td>
<td>9.1%</td>
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<td>Astatula &amp; Candler sands, 12 to 20 percent slopes (4)</td>
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<td>18.2%</td>
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<td>4.8%</td>
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<td>Astatula sand, 0 to 5 percent slopes (5)</td>
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<td>7.6%</td>
<td>9</td>
<td>4.3%</td>
<td>excessively</td>
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<tr>
<td>Astatula sand, 0 to 12 percent slopes (6)</td>
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<td>0.3%</td>
<td>6</td>
<td>2.9%</td>
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<td>Astatula sand, fire regime, 0 to 5 percent slopes (9)</td>
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<td>0.9%</td>
<td>9</td>
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<td>Astatula sand, fire regime, 5 to 12 percent slopes (10)</td>
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<td>0.3%</td>
<td>12</td>
<td>5.7%</td>
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<tr>
<td>Astatula and Tavares sands (12)</td>
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<td>1.9%</td>
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<td>Astatula &amp; Candler sands, flora rich; 0 to 5 percent slopes (13)</td>
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<td>0.1%</td>
<td>1</td>
<td>0.5%</td>
<td>excessively</td>
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<td>Paola fine sand, flora rich, 5 to 12 percent slopes (14)</td>
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<td>0.0%</td>
<td>1</td>
<td>0.5%</td>
<td>excessively</td>
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<td>4.5%</td>
<td>14</td>
<td>6.7%</td>
<td>excessively</td>
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<td>Paola fine sand; 5 to 12 percent slopes (16)</td>
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<td>1.3%</td>
<td>5</td>
<td>2.4%</td>
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<td>Orsino fine sand, 0 to 5 percent slopes (18)</td>
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<td>1.4%</td>
<td>10</td>
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<td>3.1%</td>
<td>6</td>
<td>2.9%</td>
<td>excessively</td>
</tr>
<tr>
<td>Paola sand, 5 to 12 percent slopes (22)</td>
<td>1,215</td>
<td>0.6%</td>
<td>4</td>
<td>1.9%</td>
<td>excessively</td>
</tr>
<tr>
<td>Paola sand, 12 to 20 percent slopes (23)</td>
<td>38</td>
<td>0.0%</td>
<td>1</td>
<td>0.5%</td>
<td>excessively</td>
</tr>
<tr>
<td>Orsino sand, 0 to 5 percent slopes (24)</td>
<td>3,394</td>
<td>1.6%</td>
<td>9</td>
<td>4.3%</td>
<td>moderately well</td>
</tr>
<tr>
<td>St. Lucie fine sand (25)</td>
<td>441</td>
<td>0.2%</td>
<td>1</td>
<td>0.5%</td>
<td>excessively</td>
</tr>
<tr>
<td>Archbold fine sand (26)</td>
<td>597</td>
<td>0.3%</td>
<td>1</td>
<td>0.6%</td>
<td>well</td>
</tr>
<tr>
<td>Myakka-Myakka, wet, fine sands (27)</td>
<td>750</td>
<td>0.4%</td>
<td>9</td>
<td>4.3%</td>
<td>poorly</td>
</tr>
<tr>
<td>Immokalee fine sand (28)</td>
<td>754</td>
<td>0.4%</td>
<td>5</td>
<td>2.4%</td>
<td>poorly</td>
</tr>
<tr>
<td>Basinger sand (Ba)</td>
<td>63</td>
<td>0.0%</td>
<td>2</td>
<td>1.0%</td>
<td>poorly</td>
</tr>
<tr>
<td>Delks sand (De)</td>
<td>74</td>
<td>0.0%</td>
<td>2</td>
<td>1.0%</td>
<td>poorly</td>
</tr>
<tr>
<td>Dorovan muck (Do)</td>
<td>20</td>
<td>0.0%</td>
<td>2</td>
<td>1.0%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Myakka and Sellers soils, ponded (Ms)</td>
<td>317</td>
<td>0.2%</td>
<td>14</td>
<td>6.7%</td>
<td>poorly</td>
</tr>
<tr>
<td>Pamlico muck, deep (Pd)</td>
<td>16</td>
<td>0.0%</td>
<td>2</td>
<td>1.0%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Pomello sand (Po)</td>
<td>4,687</td>
<td>2.3%</td>
<td>16</td>
<td>7.7%</td>
<td>moderately well</td>
</tr>
<tr>
<td>Sellers and Pamlico soils (Sp)</td>
<td>15</td>
<td>0.0%</td>
<td>5</td>
<td>2.4%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Sellers sand (Ss)</td>
<td>160</td>
<td>0.1%</td>
<td>3</td>
<td>1.4%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Submerged marsh (Sw)</td>
<td>83</td>
<td>0.0%</td>
<td>3</td>
<td>1.4%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Terra Ceia muck, frequently ponded (Tc)</td>
<td>17</td>
<td>0.0%</td>
<td>3</td>
<td>1.4%</td>
<td>very poorly</td>
</tr>
<tr>
<td>Water (Wa)</td>
<td>51</td>
<td>0.0%</td>
<td>11</td>
<td>5.3%</td>
<td></td>
</tr>
</tbody>
</table>

*Highlighting denotes Soil Types with highest site frequency
For the Model Building Group, the eight soil types in which 50 percent of the sites in the Model Building Group most frequently occurred were: Astatula and Candler sands, 5 to 12 percent slopes (3); Pomello sand (Po), Paola fine sand, 0 to 5 percent slopes (15); Myakka and Sellers soils, ponded (Ms); Astatula sand, fire regime, 5 to 12 percent slopes (10); Astatula sand, 0 to 5 percent slopes (5); Orsino fine sand, 0 to 5 percent slopes (18); and Water (Wa) (USDA-NRCS 2017). This last soil map unit denotes areas of standing water. Where water is found in the Sand Pine Scrub, there do tend to be sites, based on the exploration of the Model Building Group. The Water soil unit accounts for only 51 acres (21 hectares), or less than a tenth of a percent, within the over 200,000 acres (80,937 hectares) of Sand Pine Scrub, however, five percent of the sites are found around these water bodies. Similarly, Myakka and Sellers soils are described as ponded and thus represent areas of standing water.

Yet water is not the only draw, since besides these two wetter soil types, the other six with high site frequencies are excessively (n=4) to moderately well drained (n=2) sandy soils. In terms of soil type variability, nearly half (49 percent) of the Sand Pine Scrub ecosystem is associated with the Astatula and Candler sands, 0 to 5 percent slopes, but less than five percent of sites are found in this vast area. These variations in soils and site location frequencies could indicate that the Soil Types data layers may be a consistent indicator of conditions in the Sand Pine Scrub which are suited for site occurrences, and thus an important component for construction of a good predictive model.
Figure 7. Site frequency by soil type for the Model Building Group in the Sand Pine Scrub of the Ocala NF (FDHR 2018; USDA-NRCS 2017; USDA-USFS 2017; map by author).
Water Sources

The various GIS data layers acquired from the National Hydrologic Dataset (NHD) separates datasets out into point, line, and polygon features. For example, points would represent springs, line features would be creeks, while ponds or swamps would be polygon features. There are Feature Types (FType) and Feature Codes (FCode) differentiating the various kinds of hydrologic categories represented. From these designations, I sorted out the presumably more natural features (e.g., perennial lake/pond, ephemeral stream/river, spring) from what were more obviously modern, man-made, or recent hydrologic features (e.g., spillway, gaging station, sewage treatment reservoir). Given how dense these layers are and since there can be great variation between the feature types, I made comparisons between the individual hydrologic layers and the occurrences of sites by distance from these features (Figure 8 and Figure 9).

In the point water feature data, Gaging Station (FCode 36701), and Spring/seep (FCode 45800), were represented but only the latter appeared relevant for prehistoric site suitability modeling, so the former was excluded. There are approximately eleven springs currently noted by the USGS in the Ocala NF (Adamski and Knowles 2001:11). Four of these springs, though mapped by government agencies testing water quality in the forest (Adamski and Knowles 2001:48), are currently submerged by higher water levels in the Ocklawaha and St. Johns Rivers caused by the Rodman Reservoir (St. Johns River Water Management District [SJRWMD] 2021). Since the springs GIS data was incomplete in the NHD, missing these water sources that would have been more prominent prior to the higher water levels of the rivers caused by modern damming, I edited the layer to include them based on USGS and SJRWMD maps and descriptions (Adamski and Knowles 2001; SJRWMD 2021).
Figure 8. River, Stream, and Spring hydrologic features in relation to archaeological sites in the Sand Pine Scrub of Ocala NF (FDHR 2018; USDA-NRCS 2017; USDA-USFS 2017; map by author).
Figure 9. Lake/Pond, Reservoirs, and Swamp/Marsh hydrologic features in relation to archaeological sites in the Sand Pine Scrub of Ocala NF (FDHR 2018; USDA-NRCS 2017; USDA-USFS 2017; map by author).
In the line water feature data were Dam/weir (FCode 34306), Gate (FCode 36900), Non-earthen shore (FCode 41100), and Wall (FCode 48300), which were not used, as well as Stream/River (FCode 46000, 46003, 46006), which was utilized. Rivers and bays relating to the linear stream/river shapefiles, but which are larger in scale, are recorded as polygons. These included Bay/Inlet (FCode 31200), Canal/Ditch (FCode 33600), and Stream/River (46006); of these, only the canal or ditch features were excluded from the dataset as they are presumed more modern features within the Ocala NF.

The bulk of the hydrologic data for the Ocala NF was actually contained in the water bodies polygon, which encompasses features such as Swamp, Lake/Pond, and Reservoir. The specifically coded water resources were Lake/Pond (FCode 39000, 39001, 39004, 39005, 39006, 39009, and 39011), Reservoir (FCode 43600, 43601, 43605, 43612, 43614, 43615, and 43617) and Swamp/Marsh (FCode 46600, 46601, and 46602). All of the Lake/Pond and Swamp/Marsh features were utilized; however, some of the Reservoir features were excluded, like Sewage treatment pond (FCode 43612) or Disposal/tailings pond (FCode 43605). The reason for including any of the reservoir data was that some, such as the water storage reservoirs (FCode 43617) for instance, appear to have been modifications of existing low, wetland areas which may even have been ponds previously. Since this data set was the largest, I did comparisons splitting it into one with only Lake/Pond features (FType 390) and a second with only Reservoir (FType 436) and Swamp/Marsh (FType 466) water bodies.

The data layer that I found to show the most congruency between hydrologic units and prehistoric archaeological site locations for the Model Building Group was the water bodies layer denoting a combination of Lake/Pond, Reservoir, and Swamp/Marsh. This comes as a single data
layer in the NHD, and though I had tried separating out the various types, using it whole, as issued in the NHD, produced the best results (Table 4).

<table>
<thead>
<tr>
<th>Distance to Site (m)</th>
<th>Sites Near Springs</th>
<th>Sites Near Streams</th>
<th>Sites Near Rivers</th>
<th>Sites Near Lakes</th>
<th>Sites Near Swamps</th>
<th>Sites Near Lakes/ Swamps</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.0%</td>
<td>1.8%</td>
<td>0.0%</td>
<td>25.3%</td>
<td>20.6%</td>
<td>42.4%</td>
</tr>
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<td>50</td>
<td>0.0%</td>
<td>4.1%</td>
<td>0.0%</td>
<td>39.4%</td>
<td>32.4%</td>
<td>65.9%</td>
</tr>
<tr>
<td>100</td>
<td>0.6%</td>
<td>6.5%</td>
<td>0.0%</td>
<td>51.8%</td>
<td>42.4%</td>
<td>82.4%</td>
</tr>
<tr>
<td>150</td>
<td>1.2%</td>
<td>6.5%</td>
<td>0.6%</td>
<td>55.3%</td>
<td>48.2%</td>
<td>87.6%</td>
</tr>
<tr>
<td>200</td>
<td>1.2%</td>
<td>9.4%</td>
<td>0.6%</td>
<td>60.0%</td>
<td>53.5%</td>
<td>91.2%</td>
</tr>
<tr>
<td>250</td>
<td>1.2%</td>
<td>10.0%</td>
<td>1.8%</td>
<td>61.2%</td>
<td>60.0%</td>
<td>94.1%</td>
</tr>
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<td>1.2%</td>
<td>10.6%</td>
<td>1.8%</td>
<td>65.3%</td>
<td>64.7%</td>
<td>94.7%</td>
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<td>10.6%</td>
<td>1.8%</td>
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<td>68.8%</td>
<td>95.9%</td>
</tr>
<tr>
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<td>11.8%</td>
<td>1.8%</td>
<td>69.4%</td>
<td>72.9%</td>
<td>95.9%</td>
</tr>
<tr>
<td>450</td>
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<td>12.9%</td>
<td>1.8%</td>
<td>71.8%</td>
<td>75.3%</td>
<td>95.9%</td>
</tr>
<tr>
<td>500</td>
<td>2.4%</td>
<td>15.3%</td>
<td>1.8%</td>
<td>72.9%</td>
<td>76.5%</td>
<td>96.5%</td>
</tr>
<tr>
<td>550</td>
<td>2.4%</td>
<td>15.9%</td>
<td>1.8%</td>
<td>74.1%</td>
<td>78.8%</td>
<td>96.5%</td>
</tr>
<tr>
<td>600</td>
<td>2.9%</td>
<td>17.1%</td>
<td>1.8%</td>
<td>75.3%</td>
<td>81.2%</td>
<td>97.1%</td>
</tr>
<tr>
<td>650</td>
<td>2.9%</td>
<td>17.1%</td>
<td>1.8%</td>
<td>75.9%</td>
<td>82.9%</td>
<td>97.1%</td>
</tr>
<tr>
<td>700</td>
<td>2.9%</td>
<td>18.2%</td>
<td>1.8%</td>
<td>77.1%</td>
<td>84.7%</td>
<td>97.1%</td>
</tr>
<tr>
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<td>20.0%</td>
<td>1.8%</td>
<td>79.4%</td>
<td>85.9%</td>
<td>97.1%</td>
</tr>
<tr>
<td>800</td>
<td>2.9%</td>
<td>21.2%</td>
<td>2.4%</td>
<td>81.2%</td>
<td>87.1%</td>
<td>97.1%</td>
</tr>
<tr>
<td>850</td>
<td>2.9%</td>
<td>24.1%</td>
<td>2.9%</td>
<td>81.2%</td>
<td>87.1%</td>
<td>98.2%</td>
</tr>
<tr>
<td>900</td>
<td>2.9%</td>
<td>25.9%</td>
<td>2.9%</td>
<td>81.2%</td>
<td>87.6%</td>
<td>98.2%</td>
</tr>
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<td>950</td>
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<td>27.6%</td>
<td>3.5%</td>
<td>82.9%</td>
<td>90.0%</td>
<td>98.2%</td>
</tr>
<tr>
<td>1000</td>
<td>2.9%</td>
<td>30.0%</td>
<td>3.5%</td>
<td>84.1%</td>
<td>91.8%</td>
<td>98.2%</td>
</tr>
</tbody>
</table>

I utilized GIS to search varying radii around the water features to determine what percentages of the archaeological sites were found in proximity to them. As the springs, rivers, and streams of the Ocala NF are concentrated around the edges of the forest, while the Sand Pine Scrub is more centrally located within the forest, it stands to reason that these features would have less bearing on site locations. The presence or distance to wetland marshes as well as ponds and
lakes, however, showed a much clearer correlation with the sites of the Model Building Group. Almost two thirds of the sites were within 50 meters (164 feet) or one of these hydrologic features; this rate of site occurrence jumps to 95 percent when you look within a 300 meters (984 feet) radius. When this data layer was split to explore the difference between Lakes and Swamps as factors in site placement, it appears that lakes were a more significant factor at distances under 300 meters (984 feet), but further than that, swamps became a more significant variable.

**Historic Trails**

Following the United States acquisition of Florida from Spain as a territory in 1821, there was an effort by the Bureau of Land Management (BLM) to survey and create detailed plat maps (BLM-GLO 2017). These plat maps were created so the government would know about their new lands and could facilitate future land settlement; the ones which cover the Ocala NF date to between 1835 and 1852 and are comprised of Townships 11 through 17 South and Ranges 24 through 19 East (Figure 10). Overall, there were 26 plat maps and several inset or later map updates available for me to download from the online database of the BLM-GLO. These maps were georeferenced by the author as best as possible given the inherent limitations and errors of the older maps and the current, modern conditions in the forest. Features like lakes, ponds, creeks and the Township/Range grid lines were used for georeferencing. Among the prominent features on these older plat maps, beyond the basic environmental setting, are markings for trails (Figure 10 and Figure 11). Some of these may be of more recent (to the surveyor) construction and/or utilization, for example, as part of the U.S. military efforts in Florida against the Seminoles. One such instance may be seen on the plat maps, cutting through the south-central portion of the forest in an east-west line labeled “Road from Fort King to Volusia.” Fort King was located to the west
in what is now the city of Ocala, while Volusia is on the Atlantic Coast of Florida over 50 miles (80 km) distant (Gray 1972). Some of these trails, though, may be older or represent reuse of Native American pathways from the past. As previously mentioned, when visiting the forest, Simmons assumed that the trails cut through the Big Scrub were “formed” by the Seminole for hunting purposes (Simmons 1822:34).

The plat maps, having been made over several decades and by various surveyors with differing levels of detail, or even gaps in the maps, often only show segments of trails, if any are depicted at all. Further, the trails they indicate are of uncertain temporal origin, whether from the historic period, when the Seminole hunted in the forest, or from earlier periods. Even so, since the generally accurate location of these trails could be mapped in GIS, I decided to compare these paths with the location of prehistoric archaeological sites in the Model Building Group to explore any potential relationships. The argument could be made that what was a good place for a trail in historic periods would probably have been so in prehistoric periods as well, if environmental and vegetation conditions were determining factors, since those might have remained relatively similar. In several locations in the forest, in effect, there is an apparent correlation between a trail and several sites (see Figure 11).
Figure 10. Historic trails georeferenced from BLM-GLO plat maps in relation to sites in the Sand Pine Scrub of the Ocala NF (BLM-GLO 2018; FDHR 2018; USDA-USFS 2017; map by author).
Figure 11. Detail of historic trails georeferenced from BLM-GLO plat maps in relation to sites in the Sand Pine Scrub of the Ocala NF (BLM-GLO 2018; FDHR 2018; USDA-USFS 2017; map by author).
The distances between trails and sites in the Model Building Group did not appear to be as clear cut a predictive variable as hydrological sources or soil conditions (Table 5). The forest itself and area of interest (AOI) being studied are only roughly 30 km (19 miles) east-west by 60 km (37 miles) north-south, so at a search radius of 3 km (2 miles) nearly the whole footprint covers the AOI. I did, however, note that nearly one-third of sites were within 1,000 meters (3280 feet). For this reason, trail location data might be a moderate, additional predictor of site location in the Sand Pine Scrub ecosystem, but I doubt it would prove as clear cut as those provided by environmental and topographical features, such as elevation and distance to hydrological features.

<table>
<thead>
<tr>
<th>Distance to Site (m)</th>
<th>Sites Near Trails</th>
<th>Sites Near Mounds or Middens</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>50</td>
<td>1.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>100</td>
<td>2.9%</td>
<td>0.6%</td>
</tr>
<tr>
<td>200</td>
<td>7.1%</td>
<td>1.2%</td>
</tr>
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</tr>
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<td>46.5%</td>
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<tr>
<td>2500</td>
<td>57.6%</td>
<td>24.7%</td>
</tr>
<tr>
<td>3000</td>
<td>66.5%</td>
<td>28.8%</td>
</tr>
</tbody>
</table>
Prehistoric Mounds

In an effort to explore more cultural factors rather than solely environmental variables for site locations in the Sand Pine Scrub, the relationship between both prehistoric mound and midden sites in regard to site distribution was also examined (Figure 12). There are eleven of these mound sites and eight shell midden sites recorded in Sand Pine Scrub ecosystem or on its immediate periphery (within less than 100 m). Most of the mounds are recorded as having been used for burials and almost all are sand mounds, while the middens are primarily comprised of shell. These sites, the locations of which were utilized for comparison in site suitability investigations, are detailed below in Table 6. The reason for selecting these particular site types is the longer period of use, level of effort in creation, or length of occupation, when compared, for instance, with a prehistoric campsite. Also, if we presume that mounds or middens represented locations that were significant places in the social, subsistence, or ritual life of prehistoric peoples, I hypothesized they may have exerted some influence on the distribution of other types of sites in this area. The other variables included in the model and discussed so far have primarily been, in theory, only environmental in the nature. This particular variable, however, could be considered more social. In practice, social factors could also contribute to or influence the pattern of distribution of sites across the landscape of the Sand Pine Scrub. One limiting factor to the usefulness of this variable, however, would be the paucity these types of sites recorded for this region. As a variable, these mound and midden sites might not prove as useful for site suitability modeling as other more numerous and better mapped environmental variables.
Table 6. Prehistoric Mound and Midden Sites in or Near the Sand Pine Scrub of Ocala NF (FDHR 2018)

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Name</th>
<th>Site Type</th>
<th>Culture Period (FMSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8LA27</td>
<td>Alexander Springs Midden</td>
<td>Prehistoric Shell Midden</td>
<td>Mt. Taylor (4000 B.C.-2000 B.C.)</td>
</tr>
<tr>
<td>8LA4379</td>
<td>13-11, Ocala</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns (700 B.C.-A.D. 1500)</td>
</tr>
<tr>
<td>8MR7</td>
<td>Cedar Landing 3</td>
<td>Prehistoric Shell Midden</td>
<td>Orange (2500 B.C.-1000 B.C.); St. Johns I (700 B.C.-A.D. 800)</td>
</tr>
<tr>
<td>8MR25</td>
<td>Palmetto Landing 7</td>
<td>Prehistoric Burial Mound</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8MR75</td>
<td>Shell Knoll Mound</td>
<td>Prehistoric Shell Midden</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8MR76</td>
<td>Shell Knoll Landing</td>
<td>Prehistoric Shell Midden</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8MR123</td>
<td>Silver Glen</td>
<td>Prehistoric Burial Mound/Shell Midden</td>
<td>Paleolithic (10,000 B.C.-8,500 B.C.); Archaic (8500 B.C.-1000 B.C.); Mt. Taylor (4000 B.C.-2000 B.C.); Orange; St. Johns (700 B.C.-A.D. 1500)</td>
</tr>
<tr>
<td>8MR146</td>
<td>Peterson's Mound</td>
<td>Prehistoric Sand Mound</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8MR255</td>
<td>Piney Island Midden</td>
<td>Prehistoric Shell Midden</td>
<td>Mt. Taylor (4000 B.C.-2000 B.C.); St. Johns II (A.D. 800-1500)</td>
</tr>
<tr>
<td>8MR766</td>
<td>Shellef Mound</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns I (700 B.C.-A.D. 800)</td>
</tr>
<tr>
<td>8MR1102</td>
<td>F 83</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns I (700 B.C.-A.D. 800)</td>
</tr>
<tr>
<td>8MR1970</td>
<td>USFS OCA 90-15</td>
<td>Prehistoric Shell Midden</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8MR3254</td>
<td>Ocala 02-09</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns (700 B.C.-A.D. 1500)</td>
</tr>
<tr>
<td>8PU41</td>
<td>Midden on West Shore of Lake George</td>
<td>Prehistoric Shell Midden</td>
<td>Prehistoric</td>
</tr>
<tr>
<td>8PU42</td>
<td>Louis Place Mound</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns (700 B.C.-A.D. 1500)</td>
</tr>
<tr>
<td>8PU677</td>
<td>Naylor's Mound 85-8</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns (700 B.C.-A.D. 1500); Seminole (1716-present)</td>
</tr>
<tr>
<td>8PU1217</td>
<td>Pohlers Mound 98-41</td>
<td>Prehistoric Burial Mound</td>
<td>St. Johns (700 B.C.-A.D. 1500)</td>
</tr>
</tbody>
</table>
Figure 12. Comparison of prehistoric mound and midden sites, historic trails, and Model Building Group Sites (BLM-GLO 2018; FDHR 2018; USDA-USFS 2017; map by author).
A few of the mounds and middens do appear to be in areas near groups of sites and even near the trails that were georeferenced from the BLM-GLO plat maps, based solely on visualization; however, there is much less statistical correlation between them and the Model Building Group (see Table 5). Few if any sites were close to the mounds or middens and less than ten percent of them were within a search radius of 1,000 meters (3,280 feet) distant. As a variable in predictive modeling or mapping for site suitability in the Sand Pine Scrub ecosystem, these mound and midden sites do not appear to be especially useful. Little to no correlation between site locations could be drawn between the two when studied using GIS locational information.

**Constructing the Model**

After exploring the various data sources available in GIS for use in developing a predictive model for site suitability in the Sand Pine Scrub of the Ocala NF, there were several variables that appeared most promising. Most of the sites are situated between about 2 and 25 meters (7 and 82 feet) AMSL and nearly 96 percent of all the sites were within 300 meters (984 feet) of the hydrological layer for water bodies such as lake/pond, reservoir, and swamps/marsh. Further, eight specific soil types accounted for conditions at over 60 percent of the sites, while 98 percent are found within a total of 23 different soil types. I also noted that one-third of sites were within 1,000 meters (3,280 feet) of historic trails, but for the purposes of this model, this data was not utilized as it did not account for enough sites to be statistically useful in the model.

Thus, I thought three main variables, elevation, soil type, and distance to hydrological feature, would mark the highest probability factors in the model. Distance to historic trails is of interest, but I did not find it particularly useful in the construction of this model. Similarly, distance to other types of sites, like prehistoric mounds or middens, did not appear to be a relevant variable.
and, as such, were not utilized in building the parameters for this model. Summarized below are the parameters I explored for my model of site suitability mapping in the Sand Pine Scrub ecosystem of the Ocala NF and the effects they had on ‘finding’ sites in the Model Building Group (Table 7).

**Table 7. Comparison of Variable Parameters for Site Suitability Predictive Model**

<table>
<thead>
<tr>
<th>Model Variable Parameter</th>
<th>Sites Predicted (Percentage)</th>
<th>Area of Variable/Model (acres)</th>
<th>Variable/Model as Percentage of Scrub</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Soil Types</td>
<td>61.4%</td>
<td>69,234</td>
<td>33.6%</td>
</tr>
<tr>
<td>23 Soil Types</td>
<td>98.7%</td>
<td>200,832</td>
<td>97.5%</td>
</tr>
<tr>
<td>250 m to Lake/Swamp</td>
<td>95.4%</td>
<td>33,876</td>
<td>16.4%</td>
</tr>
<tr>
<td>300 m to Lake/Swamp</td>
<td>96.1%</td>
<td>39,309</td>
<td>19.1%</td>
</tr>
<tr>
<td>2 to 25 m Elevation</td>
<td>88.2%</td>
<td>81,199</td>
<td>39.8%</td>
</tr>
<tr>
<td>0 to 27 m Elevation</td>
<td>89.5%</td>
<td>95,632</td>
<td>46.4%</td>
</tr>
<tr>
<td>8 Soil Types, 250 m to Lake/Swamp</td>
<td>58.2%</td>
<td>18,096</td>
<td>8.8%</td>
</tr>
<tr>
<td>8 Soil Types, 300 m to Lake/Swamp</td>
<td>58.8%</td>
<td>20,479</td>
<td>9.9%</td>
</tr>
<tr>
<td>23 Soil Types, 2 to 25 m Elevation</td>
<td>86.3%</td>
<td>79,718</td>
<td>38.7%</td>
</tr>
<tr>
<td>23 Soil Types, 250 m to Lake/Swamp</td>
<td>85.6%</td>
<td>32,488</td>
<td>15.8%</td>
</tr>
<tr>
<td>23 Soils, 250 m to Lake/Swamp, 2 to 25 m Elevation</td>
<td>83.7%</td>
<td>29,439</td>
<td>14.3%</td>
</tr>
<tr>
<td>23 Soil Types, 300 m to Lake/Swamp, 2 to 25 m Elevation</td>
<td>84.3%</td>
<td>33,567</td>
<td>16.3%</td>
</tr>
<tr>
<td>23 Soil Types, 300 m to Lake/Swamp</td>
<td>94.8%</td>
<td>37,797</td>
<td>18.4%</td>
</tr>
<tr>
<td>300 m to Lake/Swamp, 2 to 25 m Elevation</td>
<td>86.3%</td>
<td>35,247</td>
<td>17.1%</td>
</tr>
<tr>
<td>23 soils, 300 m to Lake/Swamp, 0 to 27 Elevation</td>
<td>85.6%</td>
<td>34,550</td>
<td>16.8%</td>
</tr>
</tbody>
</table>

* Shading denotes the selected variable parameters

One thing I quickly noted in creating the model, was that leaving out the moderate probability soils greatly limited the ability of the model to ‘find’ a majority of the Model Building Group sites. Since only 60 percent of these sites are located in areas where the high probability soil types are mapped, any combination with other limiting factors like elevation or a distance...
from water meant that less than 50 percent of sites were present in the model’s predictive layer. Thus, the larger, more inclusive group of soil types were utilized in creating the model. Another problem I quickly discovered was that the elevation data, when combined with the soils and water parameters, tended to reduce the percentages of sites from the Model Building Group that the model could predict. Increasing the elevation range did not significantly improve the efficacy of using elevation as a variable in my model.

After running the comparisons with several adjustments to the ranges of the variables, whether it was a slightly larger buffer around the water bodies layer or adding several meters in elevation to the DEM layer, I finally narrowed down a set of variables that seemed to provide sufficient predictive power without creating too large a footprint in the Scrub. These parameters are summarized below in Table 8.

<table>
<thead>
<tr>
<th>Data Layer</th>
<th>High Probability Parameter</th>
<th>Moderate Probability Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Elevation Dataset (USDA-NRCS)</td>
<td>5 to 25 meters AMSL</td>
<td>-</td>
</tr>
<tr>
<td>National Hydrography Dataset (USDA-NRCS)</td>
<td>within 300-meter radius of lake/reservoir/swamp waterbody</td>
<td>-</td>
</tr>
<tr>
<td>Soil Survey Geographic Database (USDA-NRCS)</td>
<td>MUSYM of 3, 5, 10, 15, 18, Ms, Po, Wa</td>
<td>MUSYM of 2, 6, 8, 9, 12, 16, 21, 22, 24, 27, 28, Sp, Ss, Sw, Tc</td>
</tr>
</tbody>
</table>

**Testing the Model**

As noted above, approximately one-quarter of the sites plotted in the Sand Pine Scrub were held back in reserve to create a Model Testing Group. The relevant features of these sites were not used in constructing the parameters for the variables chosen based on the exploration of the Model Building Group sites. This second set of Model Testing sites was only used once the model was
completed. The features of these sites were compared with the relevant model predictive parameters to determine how accurate the model was in expecting the presence of these already known archaeological sites. This testing should help to give confidence as to whether the model might work in areas of the Sand Pine Scrub where archaeological survey work has not yet been conducted. This method of model testing was laid out by Kvamme, with the statistic that the percent of already known sites correctly ‘predicted’ by the model would reflect ‘model accuracy’ (2006:24).

For the sites utilized in the Model Building Group, the model correctly predicted 94 percent of these known sites (see Table 7; Figure 13). When it came to correctly predicting or finding the sites of the Model Testing Group, the model performed even better. It correctly located all save one of the sites which gave a model accuracy of 98 percent. This improvement in prediction from the model building to the model testing data was something I had not expected, but could potentially point to either the usefulness of the model or simply be a factor of the limited data with which to utilize in model building for the Scrub area. One significant drawback to the model is the footprint of its predicted area. At 15,296 hectares (37,797 acres) this represents 18 percent of the Sand Pine Scrub ecosystem’s 83,355-hectare (205,974 acre) footprint in the Ocala NF. By limiting the predictive model to using only the eight high probability soils, coupled with a 300-meter buffer around the Lake/Swamp water bodies layer, this footprint can be reduced to 8,288 hectares (20,479 acres), or 10 percent. This, however, reduces the model accuracy to predicting just under 60 percent of the Model Building Group sites. It is slightly better for the Model Testing Group sites, predicting 68 percent of these.
Figure 13. Map of model showing areas of site prediction in relation to previously recorded sites (FDHR 2018; USDA-USFS 2017; map by author).
One way of measuring the efficacy of a model is how well it does at predicting the greatest number of sites across the smallest area being searched. Generally speaking, if you are the one having to do the fieldwork, the less time you spend fighting your way through the Scrub hunting for archaeological sites the better; that is, a greater return for less amount of effort. The performance gain statistic utilized by Kvamme (1988) “is used extensively in archaeological site location modeling” (Galletti et al. 2013:51) and is accepted as a relevant indicator of a model’s potential effectiveness (Conolly and Lake 2006). This statistic examines how well a model does at predicting a particular desired location, in Kvamme’s original example, a terrace, in my particular case, a site, versus the prediction rate of just random chance (Galletti et al. 2013:51; Kvamme 1988). Kvamme calculated this gain statistic by dividing the model’s predicted area by the total area, as well as the number of correctly predicted locations over the total number of those locations. The ratio of these two figures is subtracted from 1. The value is a range from -1 to +1, with numbers closer to +1 showing better than chance outcomes for the model, numbers closer to -1 showing the model performs worse than random chance. A value of zero would indicate that the model is just the same as random chance (Galletti et al. 2013; Kvamme 1988). For the model I developed, when I calculated Kvamme’s performance gain statistic, I got a number of 0.81. As this number is positive, the model does perform better than random chance at predicting suitable site locations. Further, since the number is nearer to 1 than to 0, the model does significantly better than random chance. This would argue to the efficacy of this particular model when predicting suitable site locations in the Sand Pine Scrub ecosystem of the Ocala NF.

In order to compare the model variables and their parameters to the characteristics of the Model Testing Group sites, and perhaps better understand the high model accuracy, I again explored the various environmental factors chosen for creating the model, this time in relation to
this second dataset. The distribution of the elevations for the sites from the Model Testing Group tends towards the lower elevations, though the range is similar, stretching from 3 to 36 meters (10 to 100 feet) AMSL, with the bulk of the sites appearing between 8 and 22 meters (26 and 72 feet) AMSL (Figure 14). The mean elevation for this group is 15 meters (49 feet). As elevation was ultimately excluded as a model variable despite its potential predictive use, this congruency does not factor into the model comparisons, but it is possibly something to explore in any future model refinement. In terms of distance to the Lake/Swamp water body layer for the Model Testing Group, 96 percent of the sites were within 300 meters radius. Similarly, 70 percent of the testing sites were associated with the eight high probability soils and 100 percent were associated with the 23 moderate-to-high probability soils.

Figure 14. Histogram showing the frequency distribution of elevations for sites in the Model Testing data set (USDA-NRCS 2017).
CHAPTER FIVE: RESULTS AND CONCLUSIONS

From the outset, there were several significant limitations to the development of the predictive model for site suitability in the Sand Pine Scrub of the Ocala NF. First, there are definite limits on the quality, accuracy, and variety of the data acquired from the various governmental geospatial clearinghouses. There are also limits to the amount of survey work systematically completed in the Ocala NF, which in turn means that some of the site data is biased towards more readily traveled areas rather than a more thorough investigation of more representative settings in the ecosystem. Given how few large-scale surveys have been conducted within the forest and in this ecosystem in particular, most of the data on prehistoric finds that have been recorded were either isolated occurrences or represented more random finds along roads, fire breaks, or areas of timber harvest. There were only 226 sites or isolated finds to use in the Model Building and Model Testing Groups, meaning that the sample size for developing and later evaluating the model could definitely benefit from additional site and survey data to strengthen the assessments.

I had also made the decision to limit this predictive model to only address the factors involved in finding locations of prehistoric sites in the Sand Pine Scrub. The exclusion of historic sites and even isolated historic finds, though hundreds have been documented in the forest, was strategic. In adopting the theoretical perspective of HBE, less complicated and more ecologically focused explorations seemed to lend themselves to prehistoric rather than historic site prediction model creation. Developing a separate model for addressing site suitability locations for historic sites would be more typical and this was not something I chose to explore with the data.
One significant way to potentially improve the model, would be the inclusion of any prehistoric sites or isolated finds that are newly recorded in this ecosystem. Several years have passed since large-scale systematic surveys began in the Ocala NF in 2015 and 2016, so as more timber sales tracts are surveyed or other types of environmental assessments trigger archaeological surveys, more site data is likely to be generated. More data could help refine the parameters or even suggest additional variables for predicting site locations.

Finer grained analysis of the elevation data could also be used in the predictive model, as I chose to use a single centroid point for each site as representative of elevation for the site as a whole. This was done since some of the data was already in point form (i.e., isolated finds), but there could potentially be significant variation in elevations across sites. In fact, the elevation data was derived from a 3-meter interval Digital Elevation Model (DEM) and as more LiDAR data becomes available over time, more accurate DEMs could potentially become available soon. Also, the elevation data was not ultimately not incorporated in my model, but it may yet be useful on smaller scale modeling of site patterns rather than for the whole of the Sand Pine Scrub ecosystem in the Ocala NF.

Viewshed and slope are among some of the other variables which have been used in different predictive models for site suitability (Jones 2017; Wheatly and Gillings 2002); these were not variables I utilized in the current model. There is not a great amount of steep or drastic topographical change within the majority of the Ocala NF, and for this reason I did not attempt to utilize or explore any potential relationships these variables might have with sites in the Sand Pine Scrub. There could, however, be areas along the Ocklawaha and St. Johns rivers where these slopes are significant and inconstant enough to provide differentiation that could be explored in relation to site locations for the model.
Another way in which modeling site suitability in the Sand Pine Scrub might be further explored, would be through examination of the chronology of the sites found within this ecosystem. At this time, however, there does not yet appear to be enough data about the various time periods represented by the limited number of sites recorded within the Sand Pine Scrub. Several of the cultural periods designated in the FMSF database for sites note only a single representation for certain periods that are found within the scrub (see Table 1). As the vast majority of the sites are categorized only as generally ‘prehistoric’, for the model to be pushed into the exploration of settlement patterns across different time periods, more research would be needed. Refinement of the temporal periods of sites already known in the Sand Pine Scrub could aid in exploring a breakdown of the settlement patterning in the scrub by chronological periods. At present there are so few well dated sites in the data set that this seems a question better left to the future for exploration, intriguing as it may be.

Besides improving upon or adding to the variables included in the model from an armchair perspective, there may also be a more boots-on-the-ground approach to utilizing and even testing it. Part of forest management practices often include the need for surveys to determine if archaeological sites are located in particular areas or even what areas might need to be avoided due to the potential presence of these sites. This model could potentially give the Forest Staff another tool to use as part of the management of the Ocala NF in regards to the archaeological resources present in the forest. Though the footprint of the model is larger than I would have hoped, given how expansive a sea of tangled branches and close-packed tree trunks the Big Scrub can seem, it does reduce the area of focus for site suitability to less than a fifth of the overall acreage. It also offers some confidence that the vast majority of sites, at around 95 percent, are likely to be found by focusing on these higher probability areas.
The majority of the variables I focus on are environmental. In terms of optimization and IFD, since the Sand Pine Scrub is such a xeric and limiting landscape with few cultural resources presently recorded within its confines, I expected major, easily identifiable environmental factors to be highly significant influences on any observable site distribution patterns. I also expected cultural factors like other significant sites or trails cut through the scrub, to affect site suitability, but these were much less evident. Traversing such difficult vegetation as grows in the scrub can prove costly and inefficient, especially without a trail hacked through the undergrowth. With areas of high sandy bluffs, soft, deep sugar sands, and even endless, flat, desert-dry stretches, the significance of reliable water sources must have been magnified. One way of framing site suitability in the Sand Pine Scrub is noting how far people were willing to go into the thick of it. Clearly this was almost never very far from the edges for any significant, settlement-level amount of time. From the IFD perspective, ideally suitable settlement locations could be thought of as being elsewhere, beyond the margins of the scrub, closer to the rivers, as arguably evidenced by the significantly higher number and larger in scale sites. This could point to an interplay of population density factors outside the scrub pushing along with the resources within the scrub pulling past peoples into this challenging landscape.

I might argue that a strength of this model is its simplicity. It is reductive, with only two or three environmental factors being important in predicting the majority of the locations suitable for sites in the Sand Pine Scrub, but the Scrub itself is often considered a very limited ecosystem. Given how dry it is within this particular environment, and how many great water sources are all concentrated right on the edges of this ‘desert’, it does rather make sense that past peoples would have focused their activities on these margins. The Scrub was worth entering. There are sites within it. People were utilizing this area. Crossing it, too, if the number of sites in relation to the historic
trails are any indicator. But the need to be near water seems to have been magnetic, asserting a pull on the people spending their time in the Scrub, concentrating signs of their forays into this dry and sandy region at lower elevations, down closer to lakes and even swamps. And the Big Scrub, though unique, is not the only such place this ecosystem exists. Scattered along the Ridge, up and down central Florida, are other islands of this Sand Pine Scrub ecosystem. There are certainly other places on the margins that might not be as empty as they seem and might just need to be explored better.
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